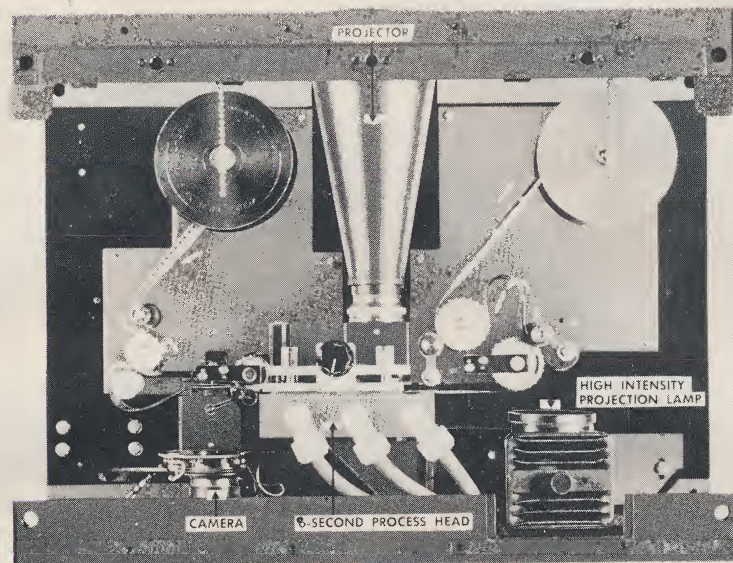


OPTOmechanisms Inc.

ENGINEERS HILL. PLAINVIEW. L. I.. N. Y

TWX CODE 516 433 9690 GE 3-8100



A HIGH-RESOLUTION
CAMERA-RAPID PROCESSOR-PROJECTOR
FOR DISPLAY SYSTEMS

By Marvin M. Saffian

The OPTOmechanisms' Series 380 Rapid Film Processor is a device used for the acquisition and display of data, as well as to provide a permanent, fully-processed photographic record of the event under study seconds after it has taken place. Typical applications are in the recording of track and target information on radar and sonar PPI's, microfilm and hard copy applications, instrument face dial readings, time-stop sequence photography in biological and chemical experiments, etc. It is a tool which may be applied with great effectiveness in expanding the potentials of air traffic control, anti-submarine warfare, and similar systems.

The operation of the equipment is fully automatic, requiring no operator attendance beyond film and chemical loading and periodic cleaning. Total time required including film exposure, development, fixing and washing is approximately eight (8) seconds. The resolution attainable at present exceeds 80 line pairs per millimeter; this, using 35mm film, is equivalent to over 4,600 TV lines. Present models use 35mm perforated film on daylight loading reels, with no limits imposed on film capacity save the user's physical size restrictions. Negative or direct reversal (positive) processing is available in all models merely by using the proper chemicals.

The system consists essentially of a camera, a patented processing head, and a projector mounted into a single unit, together with film feed mechanisms and other associated hardware. Dimensions are 19 inches wide x 14 inches high x 8 inches deep. In its usual mode of operation a single frame photograph is made of the object under study on either a pre-programmed basis or at random commands from some outside source. The exposed frame is indexed into the film processing stations, while a fresh photographic frame is simultaneously positioned within approximately 1/10 second, ready to make a new exposure. The previously exposed frame is automatically advanced through the three stages of processing, i.e., Develop, Clear/Fix, and Wash. The processed negative is then projected onto either a rear- or front-projection screen with any degree of magnification required by the user.

It may be noted here that although total processing time is in the order of eight seconds, this consideration has no effect on the maximum repetition rate at which new exposures may be made, since a variable length film loop is allowed to form between the camera station and the first processing station. This permits a short time maximum rate of exposure as high as 6-8 frames per second.

Freedom from leakage and uniform fluid flow over the emulsion are assured through specially designed molded rubber gasketing around the processing chambers. This, coupled with a negative pressure hydraulic system, assures a completely leak proof processing section under all operating conditions. The processing fluids are flowed over the emulsion; there are no jets or porous metal applicators to clog, nor is compressed air required. The film leaves the processing section virtually dry.

Processing chemicals are stored in tanks which are positively foolproofed as to their position. Insertion or removal of the tanks may be done in seconds. An important feature of the storage tank module is that it may be located remotely, within certain limits, from the processor, giving a degree of flexibility in the console design. The module's dimensions are approximately 10" x 8" x 3". A heat exchanger is used to heat the fluids to approximately 135 degrees F.

The fluids are pumped from the storage tanks through the processing head by a single peristaltic pump which handles all three fluids (developer, fixer, and wash water) but does not mix them. The pump and drive motor module may also be located remotely from both the Processor and the storage tank module. Color-coded plastic tubing is supplied for fluid interconnections. An important safety and convenience feature is that the pump is self-priming and self-cleaning. There is never any need for personnel to prime the fluid tubes in order to establish the proper pressure relationships.

A significant feature of the processor for electronic system designers is the degree of freedom available in the placement of the three modules (processor, tanks, and pump), which eases the problem of placing the equipment within a console containing other electronic gear. In addition, the freedom from fluid leakage obviates the danger of short circuit and corrosion damage to other components.

The Series 380 Processor possesses the unique advantage of being absolutely flexible as to the film materials and processing chemicals which may be used successfully, and without modification to the device itself. Timing controls for each processing stage are provided, allowing for a wide range of film/chemical combinations.

Tests run at our laboratories indicate that most thin, prehardened emulsion films -- including Ansco Hyscan, Eastman Kodak SO-242, SO-243, SO-234, etc., Dupont 131B -- may be used with consistently superior results. Processing solutions covering a wide variety of chemical formulations are available in pre-packaged kit form from OPTOmechanisms. The Series 380 Processor is also adaptable to monobath processing, using a special sludge-free rapid monobath of OPTOmechanisms formulation.

Various modes of operation may be obtained to suit the user's system requirements. In general, modifications of this type involve the programming of film movement and the judicious placement of film storage loops to provide, for example, some of the following mode variations.

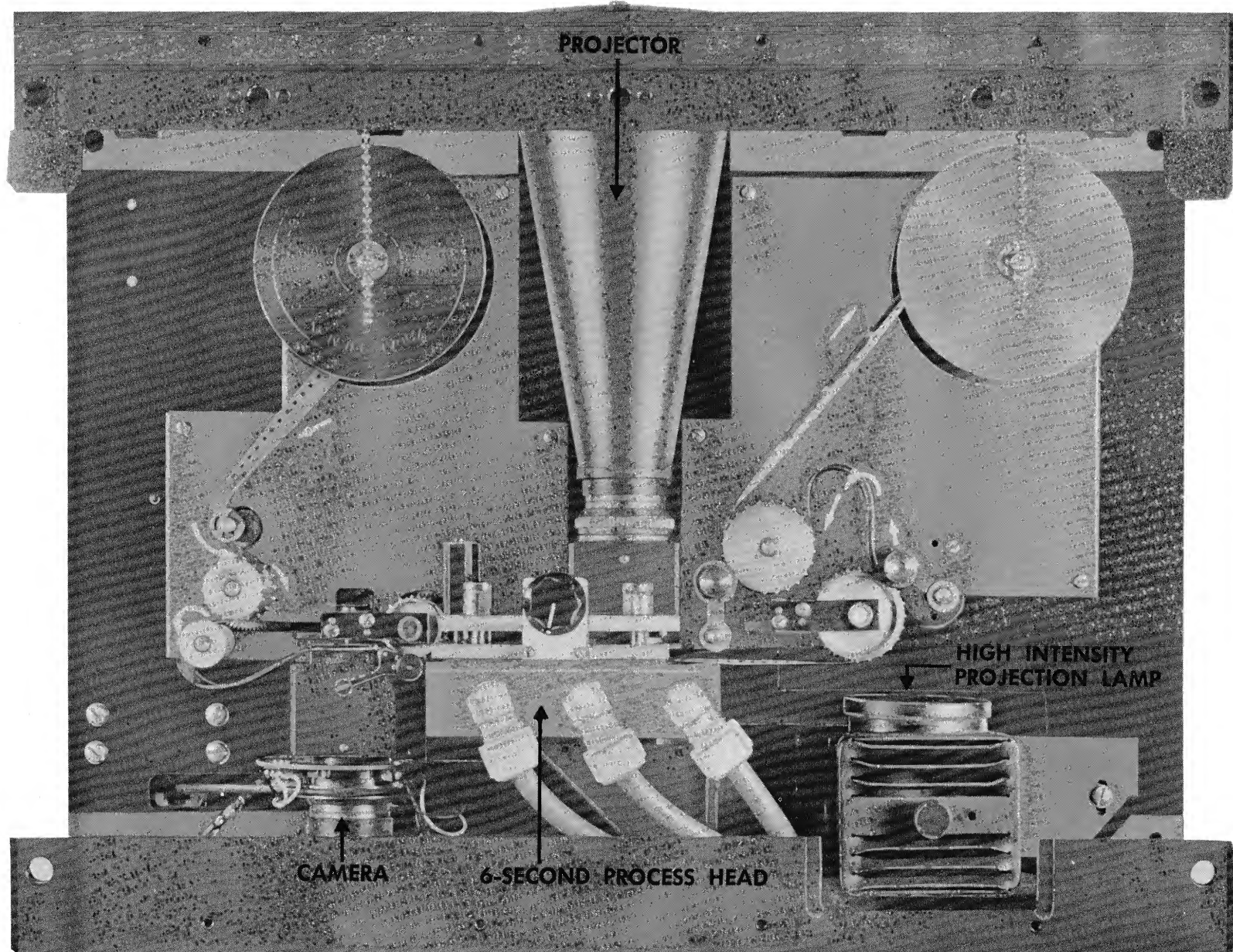
Making continual exposures on many feet of film, at any repetition rate for some minutes, and then viewing the processed frames one at a time, starting eight seconds after the first exposure, for either a fixed or variable time period. Projection back tracking is also available, as is digital coding placed at the side of each frame. The simplest, and least costly, method is to make exposures at the same repetition rate as the processing rate, and this, too, is available. The processor adapts itself very well to continuous strip processing, such as might be required for line scan radar or cartography, by simply replacing the geneva-type pull downs used in a frame-by-frame system with a continuous drive configuration.

It is evident that the variations obtainable in regard to operational mode are virtually limitless.

In summary, the OPTOmechanisms' Series 380 Rapid Film Processors fill a need long felt in the electronic and allied industries for a reliable, extremely flexible, and competitively priced, automatic film processing device which permits almost immediate viewing access to an event, as well as providing a clean, unstained photographic transparency of close to archival quality, extremely high resolution, and a range of contrasts suitable to any need.

OPTOmechanisms
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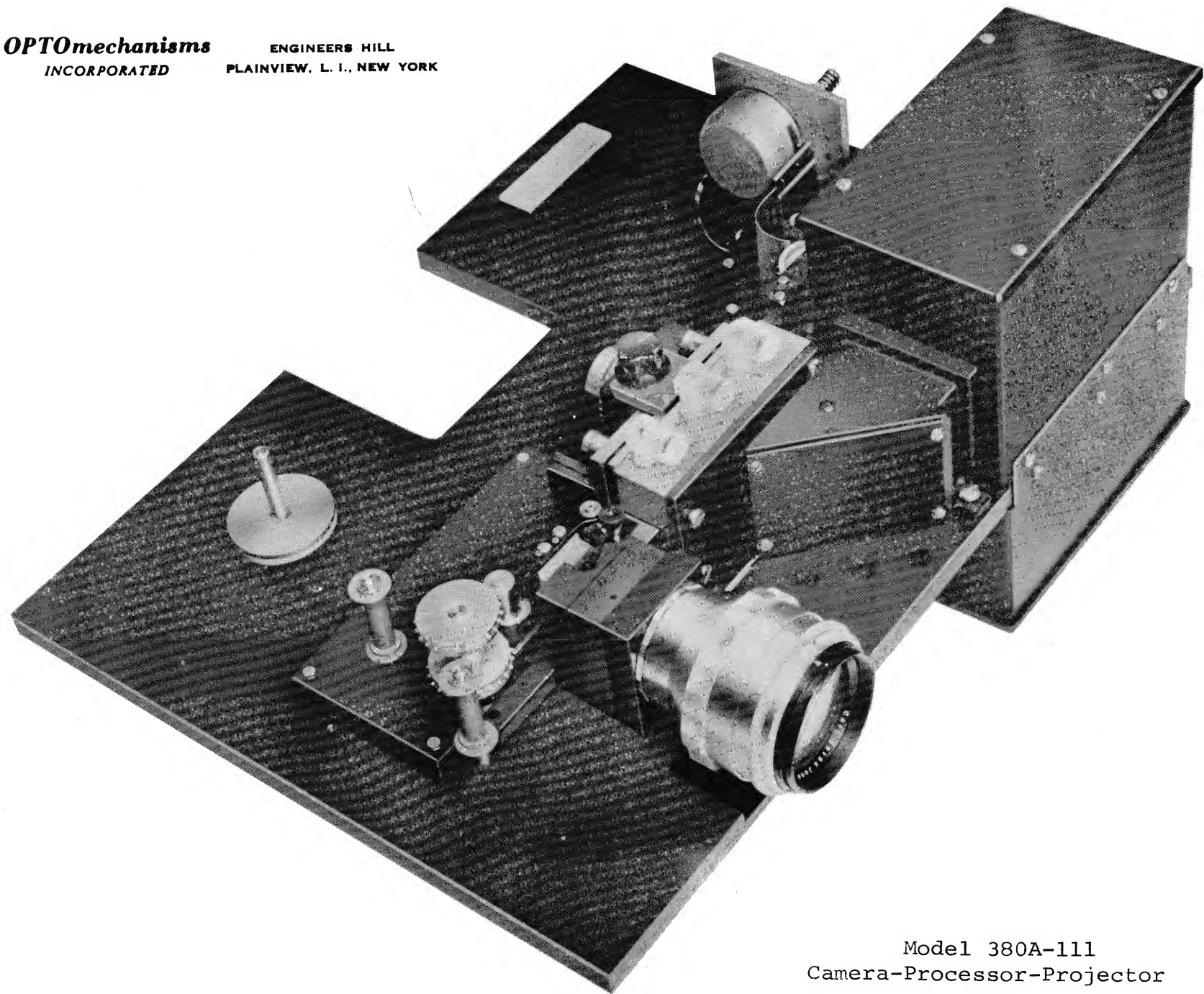
ENGINEERS HILL
PLAINVIEW, L. I., NEW YORK



Series 380A
Camera-Processor-Projector

OPTOmechanisms
INCORPORATED

ENGINEERS HILL
PLAINVIEW, L. I., NEW YORK



Model 380A-111
Camera-Processor-Projector

OPTOmechanisms Incorporated

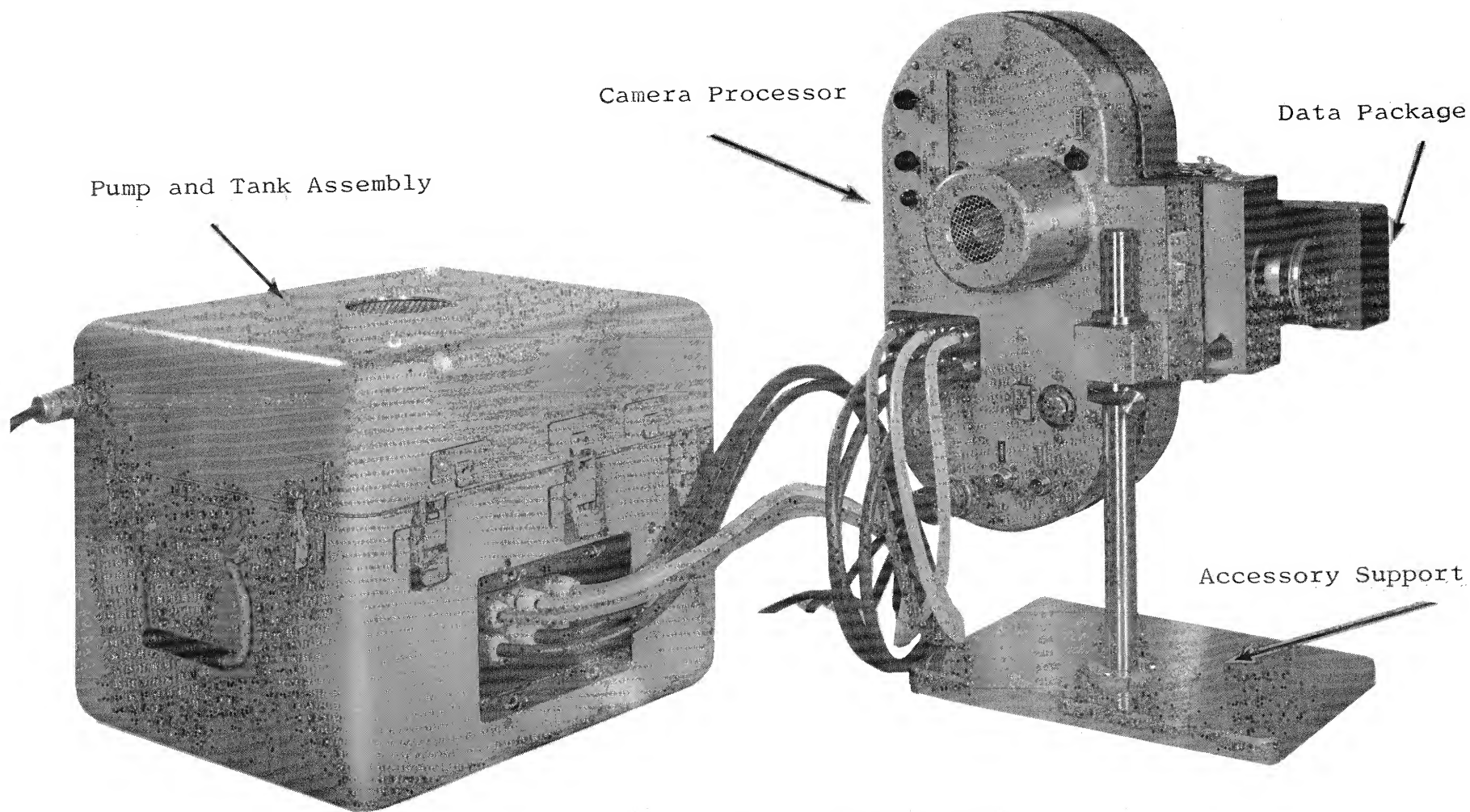
Camera-Processor-Projector
Model 380A-300



Pump and Tank Assembly
Model 380A-400



MODEL 380A-100 CAMERA-PROCESSOR-PROJECTOR



OPTOmechanisms Incorporated
MODEL 380A - 101
Photographic Processing System

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INFORMATION

multi-color group displays— the photographic approach

Marvin M. Saffian

OPTOmechanisms, Inc.

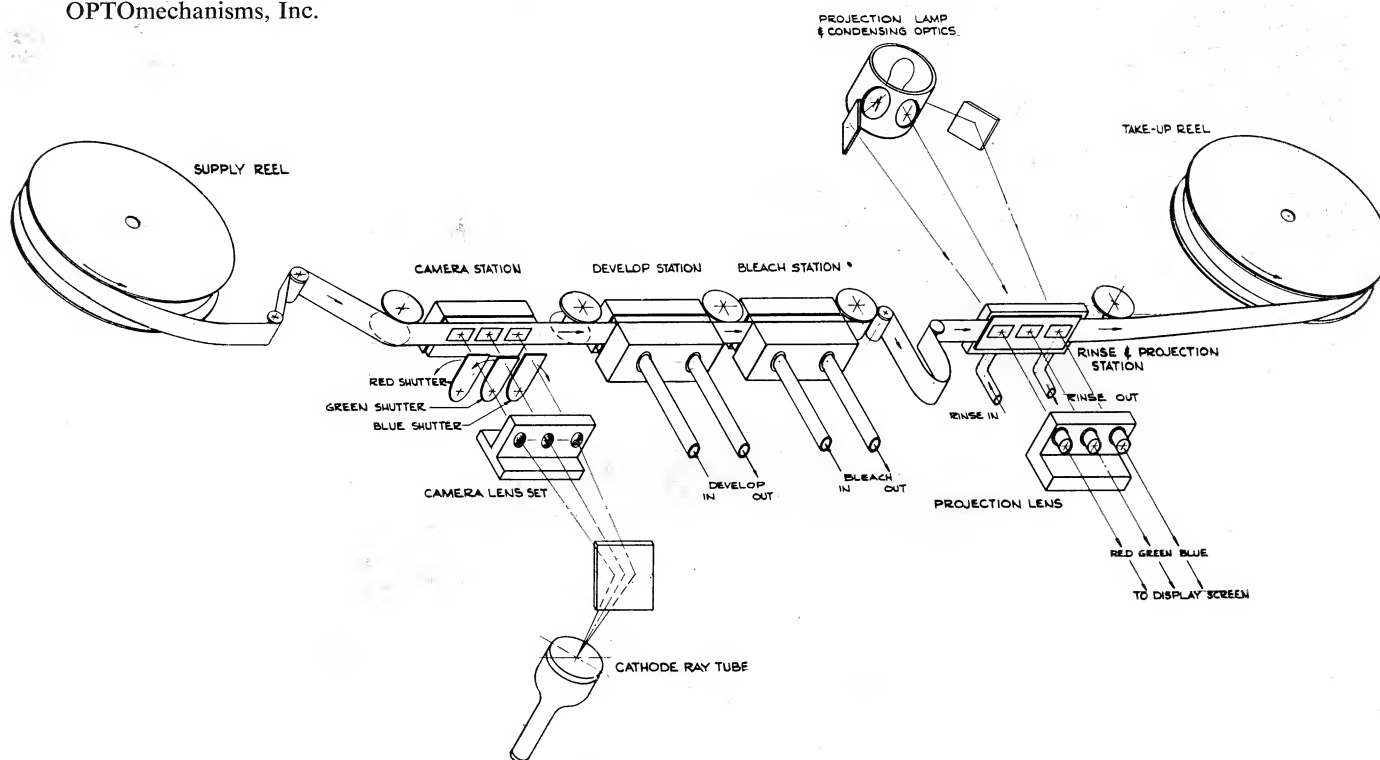


FIG 1 Multicolor display system.

IT IS GENERALLY CONCEDED at the present time that rapid photographic processing techniques are perhaps the only practical approach toward achieving the level of performance desirable in rapid-update, multi-color, high brightness group displays. (See "Large Board Group Displays," elsewhere in this issue.)

The general method of operation involves the computer-generated presentation of data on a cathode ray tube, which is then photographed and followed by an extremely rapid film processing procedure. In the relatively simple black-and-white projection system suitable for a computer readout device or a radar display, negative film processing is usually adequate, presenting dark symbology on a white background. A multi-color display requires reversal processing (or a positive image of the CRT display on the film), inasmuch as the symbology on the film chip must be clear, allowing the colored projection light beam to pass through in order to produce the desired color on the screen.

All so-called "color" systems use black and white film with a "black and white" cathode ray tube display. (Actually a P-11 phosphor is generally used, but the monochromatic film sees the blue-green readout as white against a black background.)

Stated in its simplest terms, a color-additive machine produces a film chip which consists of three black and white frames, through each of which is projected a different colored light beam. The three primary colors, red, green, and blue, are most often used. Fig. 1, shows schematically the OPTOmechanisms multi-color display equipment. All three exposures ("red," "green," "blue") are made off the same CRT; "color" information is transmitted by the data processing machine by means of open and close signals to the three "color" shutters at the exposure, or camera, station.

After exposure and rapid processing, the film chip is advanced to the projection station, where the three projection lenses (one in each "color" channel) are so placed as to cause the images from all three frames to overlay at the screen with an extremely high degree of precision. An exposure on the "red" frame, when rapidly processed to a positive, will, of course, produce the corresponding image on the screen in red; the same may be said for the "blue" and "green" frames. Thus far, except for the multiplicity of projected images, the equipment is no more complicated than a relatively simple monochromatic camera-processor-projector such as the one shown in Fig. 2. However, equipment which incorporates only

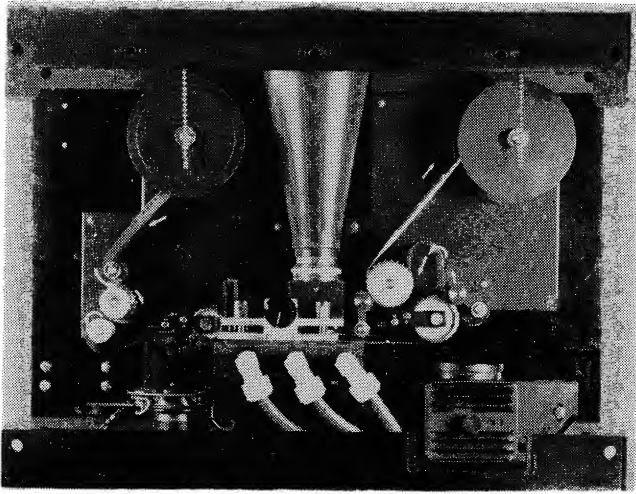


FIG. 2 Camera-processor-projector.

three color channels is potentially capable of projecting seven completely different colors by the technique of color addition. The combination of the primaries in pairs will produce magenta, cyan, and yellow, and the combination of all three primaries will produce white. The lack of primary frame alignment when projecting the secondary colors is called "color fringing," and in large screen systems, is perhaps the most important limiting factor to the amount of information which may be reliably displayed.

The development of silver halide film is essentially a negative-type process. Most manufacturers of display equipment therefore, incorporate a printing step after exposure and rapid processing of the initial film material to the CRT image. This causes a transparent "print" to be made on another film strip. The second strip is then negatively processed, which produces a positive image of the original CRT display on the second film strip. In some rapid processing equipment presently in the field the second exposure, or printing, is done on Kalvar material which may be dry developed very quickly by the application of heat. This saves some time over a secondary silver halide printing in the preparation of the positive for the newly updated chip. The Kalvar processing stage is also somewhat less complex than a second silver halide processing stage.

In general, it may be stated that a display equipment which utilizes a double processing cycle (whether the second film strip is silver halide, Kalvar, or whatever) is more complex and costly (and what is perhaps more important, slower in updating), than an equipment which can produce direct positives on the original exposure medium. The possibility of applying direct reversal techniques to rapid update display systems had always been hampered by the need for six to ten separate processing steps as opposed to only one to three for negative processing. A major breakthrough was accomplished less than two years ago when OPTOMECHANISMS announced a three step direct reversal process which could be accomplished in less than ten seconds. Since that time at least

one major command post large board (12 ft. x 16 ft. screen), multi-color system has been installed, plus a number of smaller black-and-white systems.

This approach to the problem of producing positive film images uses a purely chemical means for achieving a direct reversal on the original film strip in less than ten seconds total update time from exposure to full color projection on the screen. The quality of the film images, in terms of sensitometry and resolution, is essentially as good as conventionally processed film. Typical film densities are better than 0.2 Dmin and 2.2 Dmax, giving contrast ratios of 100 to 1. Although it cannot be stated that the film possesses truly archival quality, tests on months-old film samples have shown no significant degradation of quality and no observable staining. In addition, because of a unique method of projection directly through the third stage processing fluid (see Fig. 1) a film chip may remain on the projection gate for an hour, if necessary, with virtually no observable densitometric change, even when the projection light source is in the 5-kilowatt range.

The resolution capability of display equipment of this type is usually about double that of present CRT's used as the original display generator. Ultimately, however, the resolving power of the human eye, modified by convenience factors necessary for comfortable viewing and other human factors, determines the maximum information packing density of a display in current systems. Color-additive systems present an additional parameter which must be dealt with in the determination of visual information packing density. This parameter is "color fringing," mentioned earlier.

Color fringing is caused by certain inequalities among the three primary ("red," "green," "blue") frames which make up the full film chip, such as physical size, distortion, magnification, etc., and by the precision with which the film chip can be placed in the camera and projection gates. It is usual to group together all causes and effects of color fringing, and to specify the allowable limit as a single measurable dimension or as a percentage of screen size.

If the resolving power of the human eye is taken as one minute of arc (which is equivalent to approximately 0.1 inch at a viewing distance of 25-30 feet) one can assume the minimum limit on symbol line width to be about 0.1 inch at the display screen. This figure, in practice, is determined by the minimum line width which may be generated on the CRT, multiplied by the magnification ratios at the camera and projector. However, if the system imposes a color-fringing error possibility of, say, 0.2 inch at the screen, it is evident that the packing density of the display is no longer limited by the resolving power of the human eye, as it should be for maximum efficiency, but by the color-fringing error of the machine, inasmuch as the minimum line width which can be reliably presented in a secondary color must be something greater than 0.2 inch to achieve any overlay of color at

all. (Certain psychological factors make it possible to identify a secondary, even if the extent of the overlay is less than 0.1 inch, and, therefore, it would be incorrect to draw the conclusion that a minimum line width of 0.3 inch was necessary in a machine which had a 0.2 inch color fringing error.)

Although micro-miniaturization in the layout of the display room has not yet been demanded, the "Blivet" principle (getting five pounds into a four pound bag . . .) is always applicable to military procurements. This has resulted in the use of short focal length projection systems which have the advantage of requiring less throw distance between the projector and the screen, but also present extreme obstacles to the achievement of low color-fringing and good display brightness uniformity. However, there are systems presently operational which have a 16-ft. display at less than 23 ft. throw distance and exhibit maximum color fringing of approximately 0.1 inch at any point on the screen.

The photographic approach to large group display systems provides:

Large screens, either front or rear projection types.
High symbol brightness, with good display uniformity.

Up to seven colors, all clearly distinguishable.

Update of the entire display in ten seconds.

No degradation of resolution from that available on the original readout device.

MARVIN M. SAFFIAN is Manager of Display Systems for OPTOmechanisms, Inc., Plainview, N. Y. He joined OPTOmechanisms in 1960 as a Project Engineer, heading a group which developed the Series 380 Rapid Film Processors and other state-of-the-art display devices such as the AR-34 Negative-To-Positive Viewer. His most recent assignment was as Program Manager on a Command and Control multi-color display. He received his B.S. degree from Columbia University where he was President of Tau Beta Pi. He is a member of the Society for Information Display, SPSE and SPIE.



large board group displays

Marvin M. Saffian

COMPUTER DISPLAYS, suitable for large group viewing, have recently attracted much interest through their use in a number of large scale military Command and Control Systems and Combat Operation Centers. Modern military operations, whether they be actual offensive or defensive warfare, or merely our present peace-keeping posture which presumes a constant and always alert maintenance of second-strike capability, require extremely fast decisions based upon large quantities of information of many types and from many sources.

After data receipt and processing, computer generated information must be presented in a quickly assimilable form to various levels of decision-making personnel. At the highest levels, it is usually necessary to present a display suitable for group viewing. The generally accepted human engineering criteria for group displays make mandatory:

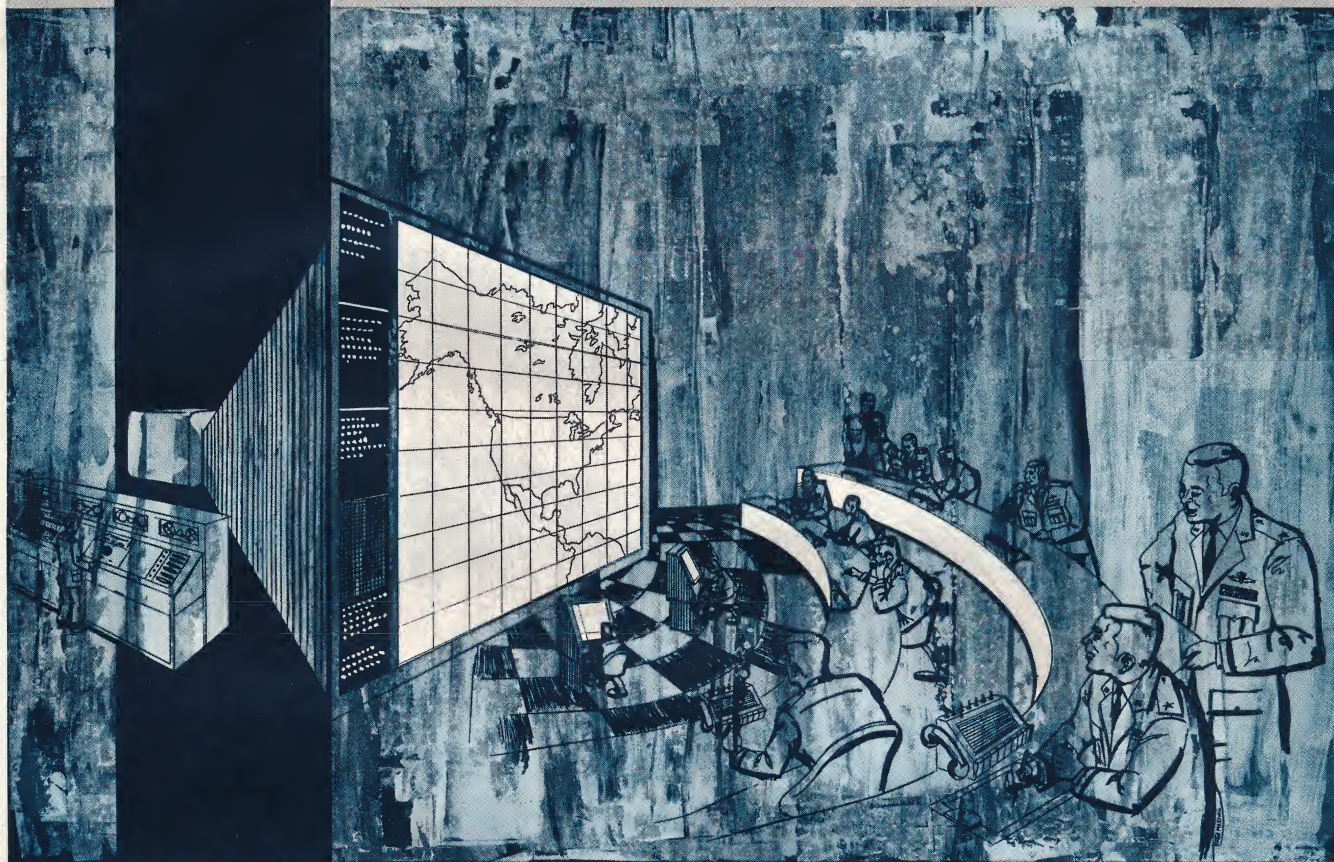
1. A *large* display, such as one finds in motion-picture theaters. Display boards 12 x 16 feet and 15 x 20 feet are not uncommon requirements.
2. A *bright* display, with symbol brightness around 20-25 foot lamberts and the retention of high brightness at audience viewing angles as wide as 120 degrees.
3. A *multi-color* display. Six or seven colors, all easily distinguishable, whether presented separately or together, provide an important additional dimension to the effectiveness of the display.
4. *Rapid-update* of the entire display, providing a minimum time lag between availability and group presentation of newly generated information. A zero time lag, resulting in a "real-time" system, would be desirable.
5. High system *resolution*, permitting maximum information packing density in each display. The ultimate limiting factor here is the resolution capability of the human eye at the distance of the Command Party from the screen.

OPTOmechanisms Inc.

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10 SECONDS

FROM DATA TO LARGE SCREEN PRESENTATION

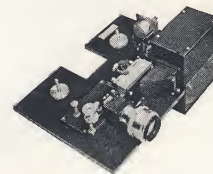


Full color data display with OPTOmechanisms rapid access processor/projection system

Only 10 seconds from computer to full color data display—front or rear projection. This advanced OPTOmechanisms' rapid up-date system delivers vital data for Command and Control Centers on theatre size screens with a symbol brightness of over 20 foot lamberts. The system processes film images by direct reversal and provides extremely high resolution presentations, at short throw distances, for group viewing. No dark room is required. OPTOmechanisms' compact Camera-Processor-Projector is completely self-contained and self-programmed. A fully detailed bulletin of this unique data display system is available.

BLACK AND WHITE CAMERA/PROCESSOR/PROJECTOR

OPTOmechanisms' black and white data display systems feature negative or direct positive film processing with a resolution range of 50-80 lines per mm. These compact, flexible, and fully self-contained systems record, process and project data in only 8 seconds. They are easily integrated with electronic sub-systems. Typical applications: data and instrumentation display, radar, air traffic control, radiological and other medical applications.



PATENT NOS. 2,981,170 and 3,115,079

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SPECIAL CAMERAS — PHOTOMETRIC DEVICES — OPTICAL TACHOMETERS — RAPID FILM PROCESSORS — PROJECTORS — OPTICAL TRACKERS
STEREO VIEWERS — SATELLITE DETECTORS — MEASURING INTERFEROMETERS — STEREO COMPARATORS — LINEAR MEASURING TABLES
STAR SIMULATORS — NEGATIVE TO POSITIVE FILM VIEWERS — ANGLE GENERATORS — FIBER OPTICS APPLICATIONS — RANGE FINDERS

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May 6, 1965

Mr. T. Nelson
Systems Consultant
Box 1546
Poughkeepsie, New York 12603

Dear Sir:

Thank you for your recent inquiry in reference to OPTOmechanisms' line of rapid access photographic products. I hope the enclosed literature will provide additional information sufficient to your needs.

We have had a wealth of experience in providing both multi-color and monochromatic display equipments for use in Command and Control, as well as general display applications, and would welcome the opportunity to discuss your requirements with you.

Please do not hesitate to contact me for any further information.

Very truly yours,

OPTOmechanisms Incorporated



Marvin M. Saffian
Display Systems

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